DOPPLER SIDEBAND SPECTRA FOR HG IONS IN A LINEAR ION TRAP*

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The sidebands in the 40.5 Ghz microwave absorption spectrum of Hg + ions held in a conventional Paul trap have been used to determine ion temperature and thus measure the size of the second order doppler frequency offset for clock operation. This paper describes a temperature measurement of ions held in a linear ion trap by interpreting similarly obtained sideband spectra.

The sideband spectra for ions in an LIT shows two peaks: A high frequency peak, displaced from the 40.5 Ghz carrier by tens of khz and a close in peak, displaced by a few kHz. The position and width of the high frequency peak are determined by the motional frequency of ions across the ion cloud diameter and are analogous to the sidebands measured for ions in a Paul trap. Ion motion in this direction is typically less than a wavelength of the 40.S Ghz radiation. The close in peak comes about because the 40.S Ghz wavefront has curvature and can interact with an ions axial velocity. The frequency of this motion is lower because of the much larger axial ion confinement length. Ion confinement along this direction is much more than a wavelength.

in order extract ion temperature and number we have carried out a Monte-Carlo simulation of the frequency spectrum of the 40.5 Ghz radiation seen by an ion moving inside a cloud of ions held in a LIT. This calculation is divided into several steps: (1) Solve the Boltzmann equation for the radial density profile for a given temperature and total number of ions;(2) From the density distribution compute the potential seen by an ion inside the cloud;(3) Select random initial velocity and posit ion and integrate the particle trajectory through the cloud ;(4) Form the autocorrelation function of the phase variation of the microwave radiation;(5) Fourier transform to get the power spectral density seen by the moving ion.

Comparison of calculated doppler sideband spectra to measured spectra will be made in this presentation.

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